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## TRANSLATION CERTIFICATION

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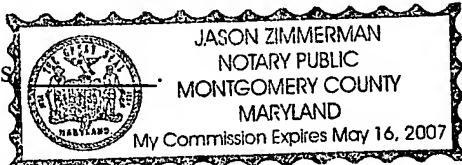
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(54) Title: Blade wheel for turbines made of ceramic materials

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C L A I M S

1. Blade wheel for turbines comprised of ceramic materials, in particular for gas turbines admitted with high temperatures, having a rim part with radial outer blades and a radial inner disc part with a hub, with the rim part and the blade part being produced separately by reaction sintering in the reactor and by hot pressing, respectively, and both parts are joined at the contact areas into a one-piece structural component by a fireproof cement, characterized in that the contact areas are formed by an inner conical circumferential surface (6) at a rim part (2) and by a corresponding external conical circumferential surface (7) at the blade part (4).
2. Blade wheel in accordance with Claim 1, characterized in that the conical contact areas (6, 7) are provided in an area of the blade wheel (1) with a large axial width.
3. Blade wheel in accordance with Claim 2, characterized in that the conical contact areas (6, 7) are provided in the area of the radial outer blade rim.

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[illegible]

Blade wheel for turbines, comprised of  
ceramic materials

The invention relates to a blade wheel for turbines comprised of ceramic materials, in particular for gas turbines admitted with high temperatures, having a rim part with radial outer blades and a radial inner disc part with a hub, with the rim part and the blade part being produced separately by reaction sintering and by hot pressing, respectively, and both parts are joined at the contact areas into a one-piece structural component by a fireproof cement.

Because the efficiency and the specific performance of a turbine, in particular a gas turbine, largely depends on the temperature of the working substance, there are now more and more attempts to increase the working temperature, which is limited with the use of metallic materials, by using ceramic materials such as silicon nitride or silicon carbide for the turbine components that carry the working substance. These materials allow an increase of the temperature of the working substance to approximately [illegible], 350 °Celsius.

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To avoid the difficulties encountered in the production of ceramic blade wheels of this type, it has already been proposed (DE-OS 2 353 551) to divide the blade wheel into a radial outer rim part with the blades, and a radial inner disc part with the hub, and to produce both parts in separate production processes, respectively. The rim part is preferably produced in a reaction sinter process where a relatively high accuracy can be achieved even for components with a complicated structure. The disc part, on the other hand, is usefully produced by hot pressing, which results in a very high strength. To connect the two components, it has also been already proposed to use fireproof cement, which is applied to the contact areas and subjected to a special thermal treatment to generate a permanent connection between the two components.

However, for the practical production of a ceramic turbine blade wheel of this type, it was provided that the disc part with the hub were to be comprised of two symmetrical individual parts which were to be pressed together axially during the gluing with the fireproof cement and in this way also clamp the rim part between them. This, however, resulted in relatively high surface areas to be connected by the cement, which furthermore have to be executed with a relatively high dimensional accuracy.

The object to be attained by the invention is therefore to proceed from a blade wheel of the type described earlier and modify said blade wheel so as to avoid all of the disadvantages described above.

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The object of the invention is attained in that the contact areas are formed by an inner conical circumferential surface at the rim part and by a corresponding outer conical circumferential surface at the disc part. Unlike the known development, this provides a continuous, conical parting surface between the rim part and the disc part produced in a single piece, which significantly reduces the area to be cemented. This guarantees a more even distribution of the fireproof cement required for the connection and the dimensional accuracy requirements for the two pieces produced in separate work cycles are substantially lower.

To create a contact area that is wide enough to generate a sufficient connection between the rim part and the disc part, it is useful if the conical contact areas are provided in an area of the blade wheel which has a large axial width, and preferably in the area of the outer blade rim.

The illustration shows an embodiment of the invention in schematic representation, which is explained in the following in greater detail. The illustration shows a longitudinal section through a ceramic turbine blade wheel in accordance with the invention, where 1 represents the blade wheel, 2 represents a radial outer rim part with blades 3, and 4 represents a radial inner disc part with a hub 5. The rim part 2 as well as the disc part 4 are comprised of ceramic materials, i.e., preferably of silicon nitride ( $Si_3N_4$ ). However, while the rim part 2 was produced in a generally known reaction sinter process where the

blades 3 can also be developed with a relatively good accuracy and without great production difficulties, the disc part was produced as a separate part by hot pressing, which is also generally known, and with the use of known flow agents. The density of the hot-pressed silicon nitride is close to the theoretical density and results in a relatively high strength of this component, which is subjected in particular to high mechanical loads. The density of the reaction-sintered silicon nitride, on the other hand, is around 0.6 to 0.9 of the theoretical density. The strength of said material is relatively low, but it is sufficient, for example, for the stresses suffered by the turbine blades. The advantages of the reaction-sintered silicon nitride are that there is practically no crawling until the very high temperatures and thus it is recommended in particular for use in structural components loaded with hot gas.

The connection between the two separately produced components, i.e., the reaction-sintered rim part and the hot-pressed disc part, is then achieved by gluing with fireproof cement, which is also known. Said fireproof cement is subjected to a thermal treatment to generate sufficient cohesion. In accordance with the invention, said contact areas should be formed by corresponding conical circumferential surfaces, in particular by a conical inner contour 6 of the rim part and a corresponding conical outer contour of the disc part 4, to obtain a sufficiently large, but not too large, area to be covered by the fireproof cement when the two parts are joined. After the fireproof cement 8 has been applied to the circumferential surfaces 6

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and 7, the rim part 2 and the disc part 4 are joined axially in the direction of the two arrows 9 shown in the illustration in the final assembly of the turbine blade wheel, and the connection is achieved by hardening the cement under slight pressure and at a suitable temperature.

As shown by the illustration, said conical circumferential surfaces 6 and 7 are provided in the area of the radial outer blade rim of the blade wheel, which has a sufficient axial width and where the stress imposed on the disk by centrifugal forces and thermal stress is still relatively low. Said connection of the two separately produced blade wheel parts at a conical [TrN: illegible, perhaps circulation area?] does not require a very high dimensional accuracy for the two single components and furthermore guarantees an even distribution of the required fireproof cement. In comparison to the other known embodiments, where the disc part had to be produced from two symmetrical components, the present disc part can be produced as a single component by hot pressing, which makes an additional connection surface obsolete. Furthermore, the radial extension of the blade rim can also be kept smaller.